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BULLETIN
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Notes on Corticium Oakesii, B. & C., and Michenera Artocreas, B. & C.

BY GEORGE JAMES PEIRCE.

Plate CX.

In the order Thelephoreæ there are many interesting species of fungi, of which the greater number grow upon the bark of trees. I wish to speak in this paper somewhat in detail of the structure of the species first described by Berkeley and Curtis as *Corticium Oakesii.*

In and upon the bark of certain species of Salix the mycelium of *Corticium Oakesii,* B. & C., spreads, forming at last a hymenium which is nearly if not quite sessile. It is shaped like a flat bowl, greyish or flesh colored, and consists of a margin of rather closely compacted hyphæ, and of the hymenial surface proper which is composed of somewhat club-shaped basidia separated from one another by hairs which are branches of ordinary hyphal threads, and constitute true paraphyses.

The paraphyses, which are short and also somewhat club-shaped, are thickly beset at their tips with short, bristle-like processes (see figure a) upon which, at certain stages at least, conidial spores may be borne. After the paraphyses have attained to such a bristly developement that they have the appearance of test-tube brushes, some of them (see figure d) begin to grow again at their tips. Those threads which do not resume their growth lengthwise become stouter and more abundantly clothed with bristles than the others. The second growth is always separated from the first by a more or less pronounced constriction (see figs. d, e, f, g) in and below which, as would be expected, the older bristles are found. The second growth is generally the last, and when it ceases bristles are again produced as before. If, however, growth is still again resumed, a third set of bristles is sometimes produced at the new tip (see figs. e, f). It is noticeable that the bristles of the second crop, although usually longer and larger than those first formed, are always fewer, generally only four. Only rarely are there more than three or four bristles in the third set.

In the second crop five or six bristles may be formed, but only four ever reach any considerable size. The paraphyses increase correspondingly in size and length. Four of the bristles grow large and long, and, though retaining in great part their thinness of wall, become erect, and bear finally on their tips single, large, oval spores. These fully grown paraphyses are therefore basidia whose sterigmata have been developed from simple, small bristles. Both the erect, upward-pointing sterigmata, and the spores which they bear, are surprisingly large. The sterigmata are about 16μ long by 4μ broad, while the bristles to which they correspond are only about 3μ long and of proportionate breadth. The spores (24μ by 16μ) are clear, granular, flesh-colored, with a nucleus, (which, however, is not always evident), and when ripe, are fairly thick-walled. The sterigmata, being thin-walled and slender, are very fragile, so that sometimes it is no easy matter to secure preparations of them. When the basidial spores are pretty well developed, the surface of the hymenium becomes yellowish and powdery, instead of close, smooth, and pallid, as it is while the plant is sterile or bearing only conidia.

When the plant is not producing basidial spores, that is, when it is young or after basidial spores have ceased to form, the bristles of the paraphyses often bear at their tips clear, highly refringent, colorless, spherical bodies about 0.82μ in diameter, which are doubtless conidial spores. There are, therefore, two fertile stages in the life history of *Corticium Oakesii*, the conidial and the basidial.

The basidial spores are therefore like the conidial spores in that they are both non-sexual, borne on bristles, or upon sterigmata which have been derived by development from bristles; but they are unlike the conidial spores in that they are only four in number, large, and colored. The only extraordinary thing about them is that they are borne on basidia which are modified and developed paraphyses whose bristles have become larger, longer, fewer, and more erect. The development of the spores is similar to that described and figured by De Bary in his "Morphology and Biology of the Fungi, Mycetozoa, and Bacteria," page 64, for *C. amorphum*, Fr.

The paraphyses branch only occasionally and the branches are always given off considerably below the tip, from that part which is still clear and hypha-like. Those branches which I saw were short, but rather large, (see fig. b).

Among the brush-like paraphyses I found numerous threads which resemble the moniliform filaments in the hymenia of *C. amorphum*, Fr. Upon each thread of this sort are from one to six bead-like structures (see fig. c). The one on the tip is generally more constricted than the others. When there is only one bead on a hypha it may become so much constricted from the rest of the thread as to be almost separate therefrom. In this stage it faintly suggests a spore.

Having found some moniliform hyphæ in *C. Oakesii* which resembled those of *C. amorphum*, I examined *C. amorphum* in order to find, if possible, some trace of the bristle-brushes of *C. Oakesii*. In this I was unsuccessful, and, so far as I know, these bristly paraphyses may be considered the characteristic possession of *C. Oakesii*. For this reason, therefore, as well as on account of certain differences in external appearance, etc., I am convinced that *C. Oakesii* is not, as had been supposed by earlier writers and more recently by Mr. A. P. Morgan in his "Mycologic Flora of the Miami Valley," "the same as *C. amorphum*," nor even a variety of the species.

In Grevillea (iii, 172), Cooke gives a brief but suggestive description of the structure of *C. Oakesii* as seen in two American specimens which he examined. He speaks of finding "incipient asci," "large sporidia," and "nodolose paraphyses," and concludes that the "spicules," or bristle-like processes of the paraphyses, are the stalks of conidial spores.

This appears to be the first paper in which the paraphyses with spicules were correctly described and their true nature pointed out. The "incipient asci" and "large sporidia" were, however, later recognized by Cooke to be basidia containing oil globules resembling sporidia. The "nodulose paraphyses" are, apparently, the moniliform paraphyses which I have just described.

The only other notice of *C. Oakesii* which needs special attention is in the paper by Massee, on the Thelephoreæ, published in the Linnæan Society's Journal, xxv, 120. He says, in *C. Oakesii*, or, as he calls it, *Aleurodiscus Oakesii*, "in addition to normal tetrasporous basidia, which are rare, there are numerous elliptical gonidia produced singly on thick gonidiophores, whereas in *Aleurodiscus Micheneri* I have found large colored gonidia."

In the specimens that I examined, normal basidia were common enough, although not always in fruit. I have seen all the stages from the young and bare basidia to those bearing four ripe spores on erect sterigmata, as I have already described and figured. I could find no trace of "thick gonidiophores," and the only normal thing which at all resembled them was, as I have said, those hyphæ whose tips were so constricted as to be bead-like. But comparing these with Massee's figures, it is evident that these are altogether too simple and commonplace to be what he means. I saw a single basidium, large, thick, and somewhat irregular, upon which was a single stout sterigma bearing a spore (see fig. h). The occasional abortion of two or three of the four sterigmata has often been observed in other genera of fungi. If wholesale abortion had taken place in Massee's specimens he would naturally have found that tetrasporous basidia were rare, and that "large elliptical gonidia produced singly on thick gonidiophores" took their place. Unless such a thing had occurred, or unless Massee was so fortunate as to get specimens of a stage different from any that I have seen, I can understand neither his descriptions nor his figures. Surely the few moniliform hyphæ, thin-walled, slender and clear, are not the gonidiophores of which he speaks, and we must choose between these and aborted basidia if we are to accept his account.

Just as these observations were ready for publication, my attention was called to a paper by Patouillard entitled, "Quelques champignons de la Chine récoltés par M. l'Abbé Delavy," which came out in the July number of the "Revue Mycologique." In this paper, under the head of *Aleurodiscus Oakesii*, B. & C., he says that the sterile cells of the hymenium are of two sorts; some are simply basidia which have not yet attained their full development; the others, much more slender, and attenuated at both ends, bear at their tips more or less spiniform protuberances; that these last might easily be taken for paraphyses, were it not that he had been able to determine that they appear in the young specimen at the same time as the basidia and never precede them; that it is, therefore, impossible to recognize in these organs the homologues of those filaments which are found in the thecæ of the Discomycetes. He says, further, that in the American specimens which he examined, the spine-bearing cells were about the same in size as sterile basidia. He therefore concludes that these are basidia which never can produce spores, and that they have become sterile because of some other function of which we are ignorant.

Now, since I have seen many of these spine-bearing cells in specimens so young that not a basidium could be seen, these spinous cells do precede the basidia. Furthermore, I have seen, and in the figures I have tried to show, the development of basidia from these spine-bearing cells themselves. It is by the resumption of growth on the part of some of these bristly cells that the basidia are formed, and from the delicate little bristles the thin-walled, large sterigmata are subsequently developed.

From my own observations, which can be confirmed at any time by an examination of the preparations which I have made of the various stages in the development of the basidia and bristle-cells, I am convinced that, in spite of the general accuracy of his account, it must be wrong on this point; that what have always been called paraphyses are paraphyses, and that from these the basidia are directly developed.

Another genus even more remarkable than *Corticium*, also belonging to the Thelephoreæ, is that called by Saccardo, *Michenera.* There is only one species known in the United States, and this is apparently not common. Like the *Corticia*, it grows upon the bark of trees. It possesses a well-marked and almost, if not quite, sessile hymenium, flat-bowl-shaped, whitish or flesh-tinted without, and rufous within. There is a decided margin to the bowl, formed of closely compacted hyphæ, as in some *Corticia*, and the hymenium itself, when ripe, ceases to be hard and smooth, and becomes powdery from the escape of the ripened spores.

The difficulties attending the study of this interesting fungus, *Michenera Artocreas*, B. & C., have been great. Its rarity, combined with its remarkable structural peculiarities, have been the cause of many confusions of nomenclature, and each student seems to have taken pleasure in re-naming this form. Berkley and Curtis seem first to have specifically described it in their "Cuban Fungi" under the name of *Michenera Artocreas;* but subsequent writers have variously styled it *Artocreas Micheneri*, *A. Michenera*, *Aleurodiscus Michenera*, and *A. Micheneri*. In addition to the confusion in synonomy, the necessarily imperfect descriptions of the earlier botanists have been accepted without thorough verification, and from this source have come some of the errors which I hope to disprove in this paper.

For the sake of clearness, I will begin my description with the young hymenium. It is made up of simple paraphyses, long, slender, and smooth, unicellular, erect, parallel and tolerably close together. Immediately beneath them, that is, at the base of the hymenium, are the ordinary mycelial hyphæ of the plant, running horizontally or obliquely and interlacing among themselves. It is, of course, from these that the paraphyses spring. Presently the tips ot some of the hyphæ become erect, swell, and force their way upwards between the paraphyses. The swollen tip becomes more granular than the rest of the hypha. Later each tip is divided off by a cross partition (see fig. k, *Michenera Artocreas*, B. & C.); it increases in size; its walls become thickened, and at the same time, by the contraction of the upper part of the cell, a long, tapering, lash-like structure is formed at the topmost point. Finally, the neck of the tip-cell, which has now grown to be flask-shaped, is closed by the thickening of its walls.

In the meantime, within the cell thus produced at the outer end of a hyphal thread, a spore has been forming. This spore is large, granular, and either colorless or faintly flesh-tinted. When the spore is ripe, the mother-cell, with its spore inside, breaks off at the partition which divided it from the parent hypha, and, together with many other similar spore-containing cells, lies rather loosely among the filamentous paraphyses until carried away by the wind, or perhaps by some other agent. When the spores are fully ripe, the long, lash-like appendages of the mother-cells show a tendency to curl spirally and to shrivel. It would be interesting to notice whether this has anything to do with the dissemination of the spores.

The spores are formed so uniformly that one may speak of three distinct layers in the hymenium. First, the somewhat loosely reticulated mycelium, which is overlaid by the more closely compacted hyphæ, from which the paraphyses and sporophores arise; then the dense layer of spores in their flask-shaped mother-cells with upward pointing flagella.

Since it was generally agreed to retain *Michenera Artocreas* among the Hymenomycetes, an effort was made to explain the presence of the flask-shaped bodies which I have just described, on the supposition that they were the spores of some fungus parasitic upon a *Corticium;* and this view was supported by the discovery in other places of basidia and spores which had the same appearance as the basidia and spores of a *Corticium.* But I find no evidence that the flask-shaped bodies are the spores of a parasitic fungus, for the hyphæ which bear the spores are the same in form, size and color as the ordinary mycelial hyphæ of the plant, and may with care be traced vertically in the body of the hymenium for some distance.

Generally, in cases of fungi parasitic upon larger or more complex forms, the hyphæ run transversely and rather near the surface of the host, and can, therefore, in sections or dissections, be distinguished or even separated from the host. Such cases as the Hypomyces, which grow on the larger Agaricini, present this character. In *Michenera,* on the contrary, the spore-bearing hyphæ run approximately parallel, deep down into the hymenium, they form nothing like a sheet, and are not much reticulated until they are near the mycelium of the plant. These flask-shaped bodies can be nothing else than large conidial spores.

If one searches in the literature, one will find in Fig. 4, Plate

VI., of Brefeld's " Untersuchungen aus dem Gesammtgebiete der Mycologie," Heft VIII, a figure which closely resembles the structure of the hymenium in *Michenera Artocreas*. This is a figure of *Nyctalis parasitica*, the nature of whose "chlamydospores," has been considered a matter of some doubt.

Basidia and spores have been described as being produced by *Michenera Artocreas*. In the hymenia, the only spores which I have ever seen were those flask-shaped conidia which I have already described. I have seen no traces either of basidia which had not yet developed sufficiently to bear spores, or of old basidia which had ceased to be spore-bearing. Yet on some specimens, growing near the *Michenera*, but, so far as I have observed, never connected with it, are often found large, low, flat hymenia in which at proper times basidia and spores are produced. These hymenia have attained their large size by the confluence of several small ones. This a rather common occurrence in the Corticia. In these hymenia the spores are large, oval, granular, and borne on long, slender sterigmata which spring from thin-walled basidia. The paraphyses, though slender are somewhat club-shaped, instead of filamentous like those of *Michenera Artocreas*. In all these respects the hymenia are Corticium-like. It is not now possible to assert positively that these hymenia have no organic connection with those which undoubtedly belong to the *Michenera;* for it is always a difficult matter to trace a mycelium continuously for more than a short distance. But it is my opinion, formed after careful examination of the specimens at my disposal, that the mycelium which produces hymenia in which are basidial spores, is not continuous with that which sends up hymenia in which are the spores borne in flask-shaped mother-cells. I believe that those hymenia which contain basidia and basidial spores are, as they seem to be, the hymenia of some species of Corticium, and that they have nothing whatever to do with *Michenera Artocreas.*

Never having seen, in any hymenium which was undoubtedly one of *Michenera Artocreas*, any traces of basidia or of spores which looked as if they might have been borne on basidia, I am led to believe that the basidial stage of *Michenera Artocreas* either does not exist at all, or that it is so completely replaced by the conidial stage (represented by the flask-shaped cells, which I have described, and the spores therein) that it very seldom appears.

The chief character by which modern mycologists recognize *Michenera Artocreas*, B.&C., is the flask-shaped, flagellate conidia. Fresh material of this plant, and if possible an abundance of it, would doubtless disclose to the student much more of interest than I have been able to make out from the herbarium specimens which have been my only material for examination. I have had the good fortune, however, to be able to study all the specimens of *Michenera* in the Curtis collection of Fungi, and also all the other specimens of *Michenera* in the Cryptogamic Herbarium of Harvard University.

In studying both *Corticium* and *Michenera* I have found Böhmer's Hæmatoxylin a valuable aid in bringing out structural characters. It must be observed, however, that acid preparations, such as glycerine and acetic acid, are impossible with this stain; for the acid gradually destroys the color after changing it to a disagreeable reddish hue. On the other hand, alkaline solutions produce a purple, flocculent precipitate. Pure glycerine is the most convenient mounting medium, and if the sections, or macerated fragments, be *slowly* run up from water to glycerine no shrinkage ensues, the color is unchanged, and the preparations may be kept indefinitely.

To Dr. Farlow, professor of Cryptogamic Botany at Harvard University, who very kindly put at my disposal the specimens which I have studied, and who has helped me by counsel and by criticism in preparing this paper, I wish to convey my grateful acknowledgments.

EXPLANATION OF PLATE CX.

Corticium Oakesii, B.&C.

a.—Simple bristly paraphysis.
b.—Showing method of branching of paraphyses.
c.—Moniliform or nodulose paraphyses resembling those of *C. amorphum*, Fr.
d.—Young paraphysis which has resumed its upward growth.
e.—Paraphysis in which second crop of bristles has been formed and growth is continued.
f.—Paraphysis, with a second crop of bristles, which will probably go on growing.
g.—A paraphysis which has been developed into a basidium, four bristles only being formed in the second crop, and these bearing large, oval, granular spores. The first crop of bristles is seen below.

h.—A basidium with only one sterizma and one spore.

i.—Detail of a crop of bristles, showing manner of extrusion, position, etc.

Michenera artocreas, B.&C.

k.—A hypha which has swelled at its tip. The tip is already cut off from the parent hypha by a cross partition. The tip is more granular than the rest of the filament.

l.—A tip which has broken from the hypha after the lash-like process from its top has been developed. The walls are still thin and the spore has not been formed.

m.—A tip cell whose much thickened walls enclose a dark granular spore (sp). The flagellate tip shows some tendency to curl. The neck of the mother-cell is almost completely closed by the thickening of its walls.

n.—A section through the hymenium of *M. artocreas.*

- I.—Layer in which filamentous paraphyses are the principal elements.
- II.—Spore-layer, mother-cells of spores lying loosely among filamentous paraphyses.
- III.—Layer of spore-bearing hyphæ which are separated from each other by paraphyses.
- IV.—Mycelium at base of hymenium, showing that both paraphyses and sporophores are continuous with ordinary mycelial hyphæ.

CRYPTOGAMIC LABORATORY,
Harvard University, June, 1890.

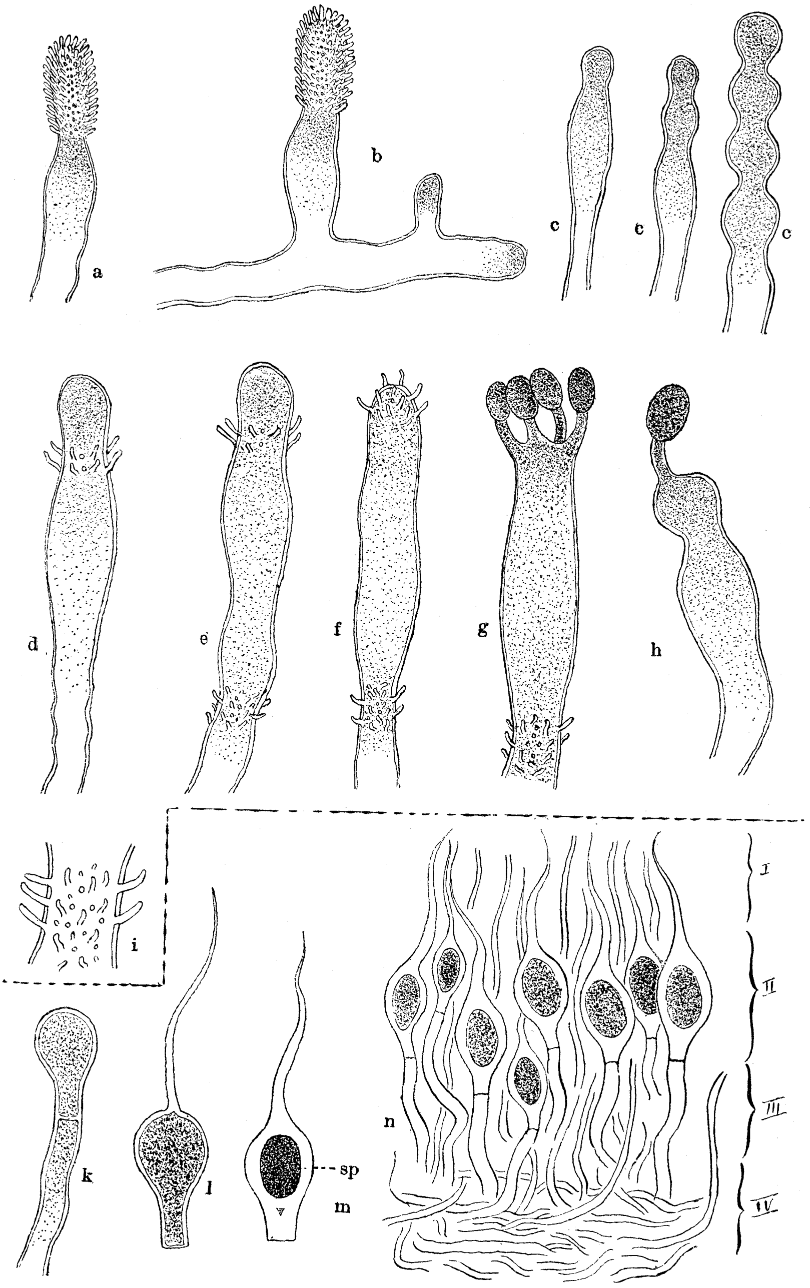
New or Noteworthy North American Phanerogams.—III.

BY N. L. BRITTON.

RANUNCULUS PORTERI, n. sp. § Batrachium. Submersed, apparently several feet long, freely branching. Leaves petioled, the petioles ½′ to 1′ long, and dilated at the base, the blade about 1½′ in diameter repeatedly ternately divided into linear or capillary segments; the upper shorter and broader; flowers white, 3″ to 4″ broad, peduncled; achenes 6 to 12 in a head, obliquely oval, compressed, somewhat pubescent, marginless, very nearly 1″ long, beakless or with a mere apiculation, irregularly rugose transversely; receptacle pubescent.

I noticed this plant in Dr. Porter's Herbarium a year or so ago. The accompanying label has only "Henry's Fork, No. 1062; *Ranunculus*, entirely immersed." It was collected on the Hayden Survey of the territories, but I cannot place the exact locality.

The species differs from any form of *R. aquatilis* with which I am acquainted, in its much broader and fewer leaf-segments and larger achenia. I sent it to Mr. Baker at Kew, who thinks it not related to any European form of that plant, remarking that "no European form ever shows so much transition between float-



Figs. a-i—Corticium Oakesii.
Figs. k-n—Michenera Artocreas.